Building and Managing sustainable schools: The case of food waste

Abstract

The global sustainability imperative requires dealing with food waste. This study explores how the management of school canteens can help school leaders on their path towards building more sustainable institutions. Despite scholars have largely shown the magnitude of food waste generated at school canteens, this paper shows that headteachers mistakenly perceive their canteens to be efficient in adjusting the amount cooked and that their pupils leave little plate waste. Data were collected through a survey among 420 school headteachers and a clustering analysis based on the schools' sustainability profile was applied. Results show that schools can be categorised in 4 clusters: Activists, Environmentalists, Socials, and Laggards. A relevant contribution of this paper is that even in those clusters largely engaged in sustainability issues, canteen food waste reduction initiatives are rarely applied. Increasing school management's visibility and awareness on the issue of food waste would result in more sustainable educational institutions. Another conclusion of the study is that although school sustainability is related to environmental rather than social initiatives, schools can follow two different paths on their way towards sustainability: either the social or environmental avenues.

1. Introduction

Climate change is real and currently recognised by the international community as a major threat to human development (Garnett, 2008). There is indeed an increasing apprehension surrounding the impacts of climate change, especially with regard to the ability of the world to provide sustainable diets for all its future population (Godfray et al., 2010). Not surprisingly, reducing food waste has been suggested as one of the most promising measures to improve food security in the coming decades (Kummu et al., 2012) and to progress towards sustainability of the food system.

Food waste has an impact on all three dimensions of sustainability: it is a growing ethical, environmental and economic problem. In developed countries most food waste occurs at the final levels of the supply chain and, consequently has a higher impact on the environment (Parfitt et al., 2010). For this reason education and awareness campaigns, although not enough, have become important in achieving the goal of improving sustainability of the food system (Garnett, 2008). The global sustainability imperative requires increasing awareness of the challenge and, as stated by Kronlid (2014), this is closely related to school education. Furthermore, schools have been identified as being in a primary position to offer education on nutrition and sustainability and in being able to influence present and future consumption patterns. Their role is crucial as food consumption patterns heavily affect the sustainability of the global food supply chain (Benvenuti et al., 2016). Therefore, the application of initiatives to reduce food waste at school canteens becomes an opportunity to promote more sustainable food habits among future generations (Boschini et al., 2017). Through reducing food waste, schools can be contributors to a more sustainable present and future food system, while reducing costs at the same time (Cohen et al., 2015; EPA, 2014). However, literature is too scanty to propose solutions to achieve this objective.

In order to shed light on this issue, the empirical approach chosen consisted of a quantitative survey among 420 school headteachers aiming to identify, characterise and classify patterns of behaviour towards sustainability in general and food waste in particular. The goal of this research is to develop a set of criteria to cluster schools based on sustainability concerns and initiatives of their top management teams and to prioritise food waste reduction initiatives that could aid in its reduction.

2. Literature Review

2.1 Education for Sustainable Development (ESD) and Sustainable Schools

Education is considered by UNESCO as a key instrument to achieve Sustainable Development Goals. As stated in several Unesco reports (e.g. UNESCO, 2017, 2015, 2005), education should become the engine of sustainable development and the key for a better world: "*Education can, and must, contribute to a new vision of sustainable global development"* (UNESCO, 2015, p. 32). This recognises the importance of education on the interaction between development and the environment.

With its roots in Education for Sustainable Development (ESD), the concept of sustainable schools, understood as those that embed sustainability principles and values in school culture, is in continuous evolution (Kadji-Beltran et al., 2013). A sustainable school has been defined as an organisation guided by the principles of care for one self, care for each other and care for the environment, integrating sustainability concerns into its daily operations (DCSF, 2008; Gough, 2005). Resource management, and thus, waste management too, are essential considerations for sustainable school policies.

According to Birney et al., sustainability is much more than "another initiative" for schools. They state that sustainability is "*life giving to people and their organisational purposes, policies and practices"* (Birney and Reed, 2009, p. 46). They continue affirming it provides schools with a robust moral framework to work within (Birney and Reed, 2009). A sustainable school should then guarantee opportunities for all staff members in learning and teaching the principles of ESD and related action (Youngs and King, 2002).

2.2. The Role of School headteachers in building Sustainable Schools

Managers' characteristics and behaviours have been found by scholars as being closely related to environmental management (Fernández et al., 2006). Sustainable school leaders place sustainability at the centre of a school's vision, mission and culture, aiming to educate students to be equipped to create more sustainable societies. These agents facilitate all staff members (teachers and administrative personnel) in developing the principles of ESD. Furthermore, Henderson (2004) states that a whole school sustainability approach implies embedding sustainability in all curriculum areas, using action learning and engaging the whole school community (Henderson and Tilbury, 2004).

At this point the role of school headteachers is crucial. Jackson (1986) concluded in her research that school headteachers who promote sustainability in their schools are usually underpinned by their personal values and thus, are passionate about sustainability. The result is a strong conviction in their engagement with sustainability. This said, Jackson (1986) found a discrepancy between the implementation of sustainable school policies and initiatives and what school headteachers say they do.

Besides, Kadji et al. (2013) when exploring constraining factors towards sustainable schools also highlight the relevance of school leaders. They point towards the limited commitment of headteachers to Education for Sustainable Development (ESD), their limited willingness to challenge the status quo and weak engagement in initiatives for supporting ESD, among other limiting factors towards building sustainable schools. They also found overall frequency of ESD actions implemented in schools was significantly linked with the headteacher's encouragement of contemporary pedagogical approaches, with participation in outside-the-classroom activities influenced by this type of encouragement.

Scott (2013, p. 10) highlights the centrality of having a leadership that *"understands the issues and owns the process of addressing them"* and posits that without this, no change towards the development of a sustainable school will

take place. He describes 4 different stages explicitly related to the role of the school leader, starting from uncoordinated initiatives lead by interested teachers, followed at a second stage by isolated curriculum activities supported or at least tolerated by school leaders. The next stage emerges with the explicit support of school leaders in taking advantage of benefits of a broad view of sustainability. Finally, at the most advanced stage, the goals of a transformed school and even educational perspective become priorities to their leaders, as shown in Figure 1.

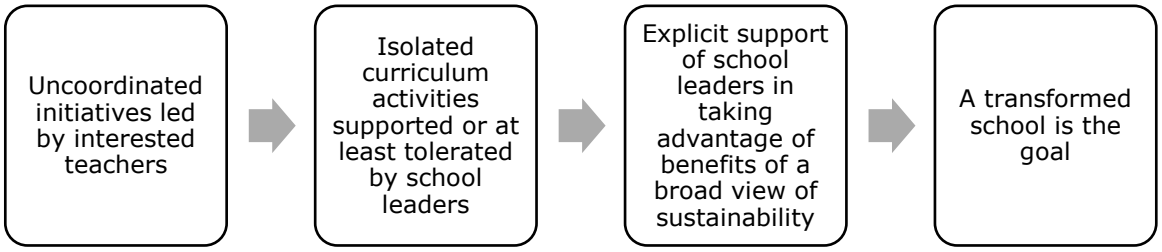

Figure 1. Stages in Developing a Sustainable School (Adapted from Scott 2013)

2.3. Food Waste at schools

Despite the fact that there is no consensus among scholars on the definition of food waste (Lebersorger and Schneider, 2011) and that diverse categorisations make its quantification difficult (Buzby and Hyman, 2012), most researchers agree on its magnitude (e.g. Mena et al., 2011) and although a great variation is observed in the quantifications performed by researchers at school canteens, results are impressive. For instance, Byker (2014) examined over 300 meals in an elementary school in the US and concluded that 45% of total food served was wasted; Boschini (2018) estimated an average of 107 g of avoidable plate waste per student and day in five primary schools in Italy, and Wrap (2011) estimated the monetary value of the food wasted at schools in the UK in 26% of the total food budget.

Food waste includes losses during preparation and cooking, discards due to preparation of too much food, expired use-by or open dates, spoilage as well as plate waste (Clarke et al., 2015), being the latter the major source of FW at schools (Betz et al., 2015). Buzby & Guthrie (2002, p. 1) list as potential causes of plate waste school scheduling constraints, the difficulty in adapting meals to widely varying student energy needs and preferences, and availability of substitute foods from competing sources.

Researchers highlight the diverse benefits of tackling food waste at schools: from improved nutritional intake by students (Byker et al., 2014) and creating more responsible future consumers (Silvennoinen et al., 2012) to more efficient water, energy and land use; diverting food waste from landfills, thus reducing greenhouse gas emissions (Parfitt et al., 2010; Wrap, 2011) and, finally, preventing unethical behaviours in a world where millions of people are still undernourished (Roe et al., 2008). Other benefits of reducing food waste at schools include financial savings for both schools and families (Cohen et al., 2013).

2.4 Food Waste Reduction Interventions

As a conclusion from different studies, scholars have come up with many and various recommendations and initiatives for institutions and firms to minimise food waste at school canteens. Mirosa et al. (2016) introduced consumer insights when analysing the reasons for wasting food, and concluded that in order to be effective, interventions should appeal to students' personal values. They reported that in order to increase student's buy-in, the reasons for reduction efforts should be explained clearly and appropriately and, thus, proper communication is

vital (Mirosa et al., 2016). On the other hand, Betz (2015) highlights the importance of increasing the staff's awareness on the issue.

Given that, in most studies, plate waste has been revealed as the largest source of waste in food service institutions (Derqui et al., 2018; Engström and Carlsson-Kanyama, 2004), suggested intervention policies have often focused on reducing diners' leftovers. Initiatives aiming to reduce plate waste include awareness campaigns such as discussing the issue in class, or even involving students in the measurement of plate waste and displaying the results in the canteen (Engström and Carlsson-Kanyama, 2004). In their study, Engström et al. reported a 35% reduction in plate waste because of an awareness campaign.

The practice of pedagogic lunches at schools – teachers discussing nutrition during the meals and teaching students how to behave in the dining room - was also mentioned as a method to minimise plate waste by Engström et al. (2004). Waling (2017) conducted a survey among 3,629 Swedish teachers on whether school lunches should be considered an educational activity or just a time to get a break from education, and found that 72% agreed on the concept of educational lunches while 28% believed lunch time should be a break from educational activities. Most respondents thought it was a good occasion for educating about healthy eating and food waste.

Research at a university residential college in New Zealand suggested that pre-ordering food can be an effective intervention technique which supports hedonism value through providing consumers' preferred meal option (Mirosa et al., 2016). Other studies suggest adding to the pre-booking of food improving the accuracy of meal forecasts before cooking and offering flexible portions (Ferreira et al., 2013). In contrast, Buzby et al. (2002) suggest plate waste could be reduced by improving food quality as well as better adapting serving sizes to students' appetites. Similarly, Guthrie (2002) concluded that increasing meal flexibility results in reduced food waste.

Interestingly, Chapman (2017) suggested that whenever recess was held before lunch time instead of afterwards, in a phenomenon described as reverse recess, plate waste is reduced; similarly, Bergman (2004), from his research in elementary school lunches, added to this conclusion the fact that nutrient consumption increases when children have more time to eat. Finally, with regard to the infrastructures and available resources, tray-free dining has also been pointed out by researchers (e.g. Ferreira et al., 2013; Whitehair et al., 2013) as a reduction measure, together with enhancing the number and the role of caregivers.

3. Objectives

Although there are quite a few studies performed by scholars on the issue of food waste (FW) at school canteens, literature is too scanty to analyse how the management of the school canteen can help school leaders in their path towards building more sustainable schools. In order to shed light on this issue, we performed research with the following goals:

1.- To understand the level of awareness on FW generated at school canteens and whether food waste generation is related to the sustainable performance of the school.

2.- To understand to what extent schools are currently applying interventions that minimise food waste at their canteens.

3.- To understand the different typologies in which schools can be categorized and to prioritise a short list of food waste reduction interventions based on their potential applicability/acceptability by each type of school.

4. Materials and Methods

4.1. Methods

Quantitative research methods were used to respond to the above-mentioned research objectives, distributing a self-completed questionnaire sent by email to 5,441 school headteachers in Spain, covering the whole school universe of both private and public, primary and secondary schools in Catalonia. The questionnaire was pretested on a small number of respondents (3 headteachers) to identify the potential problems and to eliminate them. The final research sample was subsequently chosen from official open access databases and the survey was sent to all the schools in the database. E-mails including a link to the questionnaire were sent out in February 2016. We received 548 valid responses out of which we used 420 (77%) for our research. These were chosen given the usefulness to our research objectives in responses from schools which offered dining services to their students. Thus, 128 responses were purposely excluded as these schools did not offer canteen service to their students.

4.1.1 Measures

Being Global Reporting Initiative (GRI) standards (GRI, 2016) the most commonly accepted metrics (Székely and Knirsch, 2005; Willis, C. A., 2003), GRI criteria were followed to investigate at which stage in the path towards sustainability the schools were. Although there is still a debate on which are the best guidelines to follow when measuring the sustainable performance in the public and third sector, and despite their current lack of taking up GRI guidelines (at least not as often as in the private sector), using them represents an opportunity to achieve more (Dumay et al., 2010). Questionnaire items were developed using GRI criteria, aiming to measure whether headteachers consider their institutions as having a clear and consistent sustainability strategy and to what extent they devoted efforts and resources to reducing their environmental impact. Moreover, a list of diverse potential activities was prepared and tested to confirm the level of maturity of the school with regard to sustainability. These activities included for instance the grade to which the school devotes efforts and resources to reduce the consumption of energy and water, or to promote social causes and volunteerism, among others.

Furthermore, previous research suggests that different actors are involved in the generation of food waste (Beretta et al., 2013) and that different behaviours result in different amounts of food wasted. Therefore, food wasting was measured with three variables: perceived amount of food wasted; level of involvement of the different players in reducing food waste and who is considered responsible for food waste reduction measures. Finally, the food waste reduction initiatives included in the questionnaire were chosen based on an extensive literature review (36 scientific papers were analysed). The initiatives were classified in three categories based on their scope (Derqui, Fernandez, & Fayos, 2018): the first category, interventions related to increasing awareness on the topic; the second, interventions that require modifying operational issues; and the third, those related to infrastructures and resources.

Overall, the questionnaire consisted of five sections and 78 items and was self-administered by the respondents. The complete questionnaire is included in Appendix 1. In section one, we asked for personal (name and position of the respondent) and institutional information (number of pupils, whether the school had a canteen, and whether it had a sustainability certification of any type). Section two included questions on how the canteen was managed, the number of students that typically used it, and whether they performed food waste audits. Section three aimed at understanding the school's engagement towards sustainability, including questions related to the amount of resources and effort dedicated to sustainability issues. This section included eleven 5-point Likert scale questions concerning the degree to which headteachers thought the school was engaged with sustainability. Three of the questions (CS1 to CS3) concerned general aspects related to corporate sustainability (CS), four questions (ES1 to ES4) delimited the characteristics of the institution's environmental sustainability (ES) profile, and another four questions determined the social sustainability (SS) profile (SS1 to SS4). Section four aimed at understanding school

perspectives on food waste (FW), trying to ascertain how relevant the issue is in their institution as well as who they consider responsible for the effort of reducing waste. In this section, twelve Likert scale questions (FW1 to FW12) were used. The Likert scales in both section 3 and 4 were 5-point scales where 1 was "*I do not agree at all*" and 5 was "*totally agree*". Finally, in section five, several interventions were listed and respondents had to grade them using a 5-point Likert scale based on how interesting, and applicable, they perceived the intervention to be in their school setting, where 1 indicated "*I do not think this is interesting at all*", and 5 was "*We should definitively implement it in my school*". In cases where the initiative was actually being implemented at that time at the school, the respondent could answer "*currently implemented*" instead of using the ranking scale. Although the questionnaire was sent in Spanish and Catalan languages, in this paper we have included an English translation in Appendix 1.

On top of asking about the interviewees' general interest on applying measures to reduce food waste in general (S1), 14 concrete interventions were included in section 5 in our questionnaire, as shown in Table 1.

Table 1 Food Waste Interventions found in the literature

Typology	**Intervention**	**Author**
Awareness	Plate waste awareness campaigns addressing pupils	(Engström and Carlsson-Kanyama, 2004)
	Kitchen waste awareness campaigns addressing staff	(Betz et al., 2015)
	Improve training of caretakers on food waste and sustainability	(Derqui et al., 2018)
	Cost estimations of Food Waste	(Wrap, 2011)
	Fruit peeling workshops (teaching the youngest on how to properly peel fruit to minimise waste)	(Derqui et al., 2018)
Operations	Modified timetables so that there is a recess before lunch	(Chapman et al., 2017)
	Longer lunch times	(Bergman et al., 2004)
	Improve kitchen – school communication, to be able to better adjust cooked food to real needs	(Derqui et al., 2018)
	Flexible portions	(Guthrie and Buzby, 2002)
	Optional side dishes	(Guthrie and Buzby, 2002)
	Limiting availability of bread	(Guthrie and Buzby, 2002)
Infrastructures & Resources	Improved canteen atmosphere by noise reduction	(Wrap, 2011)
	Facilitating school compost or food donations	(Wrap, 2011)
	Increase the number of caretakers	(Waling and Olsson, 2017)

5. Results

5.1 Demographics

The study target population consisted of Primary and Secondary Education Schools in Catalonia, Spain. A total of 82% (n = 346) respondents had a top management role in the school (Director/ Headteacher); 7% (n = 28) were responsible for the management of the canteen and the rest had administrative or pedagogical roles in the school (Head of studies/Administration), as shown in Table 2.

Most of the schools in our sample (76%) were public while the rest were private. By number of students, 23% of the centres in the study sample were big schools (over 400 students), 38% were medium schools (between 200 and 400 students) and 39% were small schools (fewer than 200 students), as shown in Table 2. The average number of students dining daily in the school canteen in our sample was 125, with 20 schools with over 400 pupils eating at school daily, 179 between 100 and 399 and 219 serving food to below 99 students on average.

Table 2. Sample profile (in %)

Canteen Business Model		Respondent Role at School		Size of Schools (Number of Students)	
In situ kitchen	63 %	Top Management	82%	Mean (SD)	263 (362)
Cooked outside	38%	Administration	11%	Up to 200	39%
Number of students dining at School		Canteen Manager	7%	Over 400	23%
Mean (SD)	125(143)			200 – 400	38%

5.2 School Approach on Sustainability

5.2.1 Feature Selection method and School Sustainability

Feature selection methods aim to create a more accurate predictive model based on a large dataset. Independent variables are latent constructs measured through the survey items. To find the most influential combinations of inputs, a factor analysis was conducted aiming to reduce complexity. After reducing the number of variables, the resulting simpler model is easier to understand and explain. Concretely, we applied a filter method (Guyon, 2003) which consists on selecting subsets of variables as a pre-processing step, independently of the prediction performance of the model. Accordingly, we filtered each construct computing the Internal Consistency Reliability (ICR) as measured by Cronbach alpha factor (see Table 3). By evaluating the scores, we determined if some items are to be kept or removed from the dataset in order to satisfy the conventional thresholds of 0.7 for Cronbach alpha (Peterson, 1994). Results in Table 3 show that the items do not present any outlier and are convergent (valid) for the constructs they measure.

Table 3: Feature Selection technique

Constructs	Variable Abbreviation	Combined items	Factor analysis
Suggested Interventions	SI	S1 to S17	ICR = 0.83

School environmental sustainability efforts	ES	ES1 to ES5	ICR = 0.84
School social sustainability efforts	SS	SS1 to SS4	ICR = 0.74

When asked whether they perceived the school to have a clear strategy on sustainability (Item CS1), our respondents' average grade was 3.2, as shown in Table 4. We can infer from these answers that school headteachers are quite confident with the sustainability performance of the schools led by them. With regard to sustainability certifications (Item I4), 36% (n = 152) schools gave a positive answer to the question on whether they had a sustainability or environmental certification of any kind. Furthermore, results suggest that school headteachers perceive their schools as being more engaged in environmental sustainability than in social or corporate sustainability, as the average grade for environmental items (ES mean = 4.53) was higher than for social sustainability issues (SS mean = 3.46). On a different matter, the majority of school managers agree on the pedagogical purpose of school lunches (FW1 mean = 4).

Table 4: Means and Standard Deviation for Scores of School Sustainability

	Mean	Standard Deviation
CS1: Clear Sustainability Strategy	3.21666667	1.07619427
CS2: Ahead of other Schools	2.69285714	1.03561699
ES: Environmental Sustainability	4.53869048	1.83816288
SS: Social Sustainability Efforts	3.46071429	1.78358141
FW1: Canteen in Educational Project	4.00238095	1.12574305

5.2.2 The issue of Food Waste

With regard to food waste produced at the canteen (Table 5), consistently with the literature, school managers do not think the canteens generate a lot of food waste: the average grade to the question "*Do you agree with the statement: a lot of food is wasted in the school canteen?"* (Item FW2) was only 2.3. At the same time, the mean answer to whether the amount of food cooked is usually greater than needed was low (FW4 mean = 2.6). Moreover, our respondents mostly agreed with the statement "*Children usually completely finish the food on their dishes*" (FW3 mean = 3.9). We can infer from these results that school headteachers' awareness on food waste is low, a fact that we connect to its low visibility, as concluded by Derqui et al. (2016) as well as to headteachers not being close to where waste is produced (US General Accounting Office, 1996).

Table 5: Means and Standard Deviation for Scores of Food Waste Management

	MEAN	**Standard Deviation**
FW2: A lot of FW is generated	2.2952381	1.03332362
FW3: Most pupils eat everything	3.9	0.88987945

FW4: More portions prepared than needed	2.59047619	1.16385696
FW7: Management involved	2.0952381	1.0502761
FW8: Regional Gov. involved	2.91666667	1.29629851
FW9: Parents are responsible	3.38809524	1.15787279
FW10: School is responsible	21.1880952	3.74871194
FW11: Catering responsible	2.13809524	1.03632184
FW12: Regional Gov. responsible	3.37142857	1.01310876

As regards Canteen Management (CM) and Food Waste audits (Item CM16), 33% of participants (n = 138) stated food waste had never been measured in the school canteen while 21.7% (n = 91) said food waste had been measured at least once and only 15% (n = 62) of respondents stated food waste was periodically measured in their schools. The rest acknowledged they did not know whether food waste had ever been measured or not.

Results show that little is currently being done in general at schools to minimise food waste, as shown in Table 6. The average rate of the proposed 14 interventions was 22% of the schools implementing any of them. Those that were most frequently mentioned as already being implemented in the schools in our sample were noise reduction in the canteen (with 43% of the schools) - in order to provide a more comfortable atmosphere, flexible portions (39%), caregivers' training (35%) and composting (31%).

Table 6 Frequency of Implementation by Initiative

	YES	**NO**
S1: FW reduction measures	28%	72%
S2: Regular measurements	15%	85%
S3: Cost estimations	9%	91%
S4: Awareness campaigns (pupils)	25%	75%
S5: Awareness campaigns (employees)	20%	80%
S6: Recess before lunch	32%	68%
S7: Extended lunch time	19%	81%
S8: Class Contests	3%	97%
S9: Fruit peeling workshops	18%	82%
S10: School-Canteen communication	35%	65%
S11: Menu alternatives	3%	97%

S12: Flexible portions	38%	62%
S13: Optional side-dishes	16%	84%
S14: Limiting bread	18%	82%
S15: Reduced noise	43%	57%
S16: Composting	31%	69%
S17: Increased number of supervisors	13%	87%
S18: Caregivers' training	35%	65%
Mean	**22%**	**78%**

5.3 Correlation Analysis

As shown in Table 7, we found a good correlation (R-Squared = 0.42) *between CS1 and* ES, showing that sustainability strategy is very often a synonym for environmental sustainability, while this relation does not appear with statements related to social sustainability (SS), showing that social issues are not so directly related to sustainability by school managers.

Table 7 Correlation Analysis

	CS1	CS2	ES	SS	I4
CS1	-				
CS2	0.54***	-			
ES	0.42***	0.27***	-		
SS	0.10***	0.07***	0.18***	-	
I4	0.19***	0.18***	0.08***	0.01**	-

Signif. codes: ***p<0.001 ; **p<0.01

This said, we found a correlation (R-Squared = 0.27) between the following statements: "*Our school has a clear and consistent sustainability strategy*" (CS1) and "*the school devotes efforts and resources to the reduction of food waste" (ES5),* showing a relationship between the concept of sustainability and food waste.

5.4 Clustering

Further data analysis in this study was conducted using K-Means clustering algorithm using the '*multidplyr'* package available from the Comprehensive R Archive Network (CRAN). In a snapshot, clustering algorithms can be divided into centralised and hierarchical approaches. The hierarchical clustering consists on treating each observation as a separate cluster, then to identify the two clusters that are closest to merge the most similar ones. The algorithm keeps

continuously running until all the clusters can be merged together according to their distance. In our case, we use the Euclidean distance between clusters, which can be calculated based on the length of the straight line drawn from one cluster to another. Our method creates a hierarchy of clusters represented in a tree-like diagram, called a Dendrogram (Figure 2).

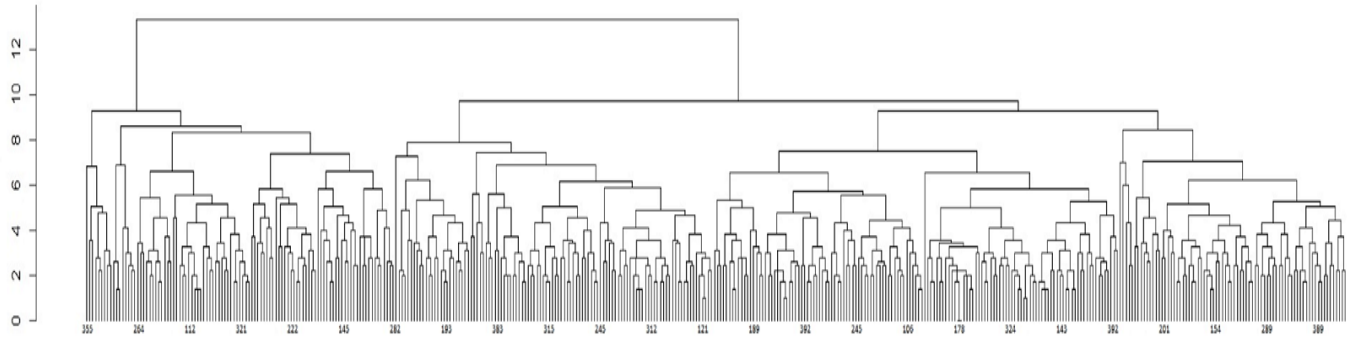

Figure 2: Cluster Dendrogram

Results, shown in Figure 2, reveal an oversized dispersion of results but a possible cut-off exists with 4 clusters (height = 9.33). Based on this output, we ran a supervised machine learning approach to characterize each of the 4 clusters. The machine defines a multi-dimensional space of the different variables wherein there is an intention of clustering. We use the K-means algorithm wherein for our study we set K=4. K refers to the number of centroids we expect in the dataset. This is the reason this method is also called centralized. A centroid is the imaginary location representing the center of the cluster. 'Means' refers to the least squared Euclidean distance between the observation and the centroid. The "nearest" mean is used to find a centroid. The machine recursively allocates every point to the nearest cluster through reducing the in-cluster averaging of distance and keeping so the centroids as small as possible. The calculation does not finish until the centroid of the clusters do not change. At the end, the resulting group of points (with the same nearest centers) are considered to be the desired clusters.

We observe four differentiated clusters of schools, which respond to diverse views and prioritisation related to sustainability issues:

- Those schools that stand out in most sustainability related constructs form **Cluster 1**, which we have coined the **Activists**. Schools in this cluster are bigger in size compared to clusters 4 & 2. 48% of the schools in this cluster own a sustainability certificate and their leaders state they have a clear sustainability strategy (CS1 mean = 3.88), which they even consider is ahead of most peers (CS2 mean= 3.27). This group ranks higher than the other three in all the environmental and social aspects. It also has the highest grade of "currently implemented" answers to all the proposed initiatives, with an average of 33% actions implemented.
- **Cluster 2, the Environmentalists,** is formed by those schools that grade higher on environmental sustainability constructs (ES1-ES4), such as "*the school allocates resources and makes efforts in reducing paper use*" (mean = 4.24), energy usage (mean = 3.92) or water usage (mean = 3.92). In this cluster, 46% of the schools own a sustainability/environmental certificate.
- **Cluster 3, the Socials,** groups those schools that ranked high social sustainability related issues, such as allocating resources to social causes in the school environment (mean = 3.58), promoting volunteer programmes among students (mean = 3.51) or supporting NGOs (mean = 3.31). They form the Social Cluster.
- Finally, we named **Cluster 4 the Laggards**, as it includes those schools that seem to be out of scope in sustainability issues. Only 7% of the schools in this cluster own a sustainability certificate and they rank lowest in all sustainability related issues.

Consistent with Jackson (1986), we found a discrepancy between what school headteachers say they do and the implementation of sustainable initiatives and policies: even in the Activists Cluster, the average % of "already implemented" for the proposed specific initiatives was found to be low (33%). In the case of the Laggards cluster,

this percentage was only 15%. In contrast, we observed a general high interest in applying initiatives to reduce food waste (S1 mean = 3.8) and performing waste audits (S2 mean = 3.7) showing that the idea of reducing food waste is regarded as positive and related to building a more sustainable school. With regard to the interest shown by our interviewees on the application of the different initiatives, we found no big differences among the clusters as both schools with high and low levels of implementation of initiatives declared high rates of interest on applying certain initiatives. The detailed characteristics of each cluster are presented in Table 8.

Table 8. Detailed characteristics of each cluster

Item number			**Laggards #4**	**Socials #3**	**Environmentalists #2**	**Activists #1**
	Number of schools		54	103	125	138
	Number of students in the school	Mean (SD)	230 (159)	315 (239)	267 (317)	335 (245)
CS1	My school has a clear Sustainability Strategy	Mean (SD)	2.06 (0.92)	2.58 (0.81)	3.51 (0.85)	3.88 (0.84)
I4	My school owns an environmental certificate	Yes	7%	24%	46%	48%
ES1-ES4	Environmental sustainability profile	Mean (SD)	2.70 (0.94)	3.23 (0.76)	3.99 (0.65)	4.32 (0.64)
SS1-SS4	Social sustainability profile	Mean (SD)	2.11 (1.13)	3.67 (.95)	2.91 (1.08)	4.32 (.78)
FW1	Pedagogical Lunches	Mean (SD)	3.42 (1.37)	3.85 (1.16)	4.42 (.83)	3.92 (1.12)
FW7	Top management engaged in FW reduction	Mean (SD)	2.44 (1.11)	2.87 (.92)	4.06 (.94)	3.47 (1.09)
CM16	Food waste is periodically measured	YES	13%	29%	25%	17%
S4 – S17	Frequency % of FW reduction actions being implemented		16%	21%	23%	33%
S4 – S17	% Top 2 (grades 4/5) Among those not yet implementing	TOP TWO	50%	53%	47%	51%
S1	Interest in applying actions	Mean (SD)	3.77 (1.05)	3.83 (1.09)	3.81 (1.22)	3.79 (1.13)
S2	Interest in measuring FW	Mean (SD)	3.76 (1.09)	3.85 (1.12)	3.57 (1.20)	3.59 (1.2)

As Figure 3 shows, the Activists Cluster grades are higher in all sustainability related issues, at the same time as the Laggards Cluster grades are lowest. With regard to the Environmental and Social clusters, clear differences are found between the average grades given for social sustainability issues compared to environmental sustainability issues. Worth highlighting, Laggards declare to be making a bigger effort on environmental issues than on social issues.

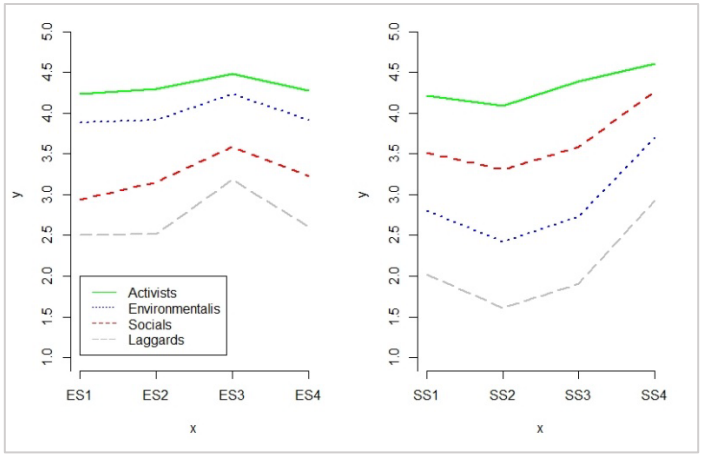

Figure 3 Environmental and Social profile of each Cluster

5.5 Current implementation of Food Waste Reduction Initiatives

We explored the resulting clusters with the rate of current implementation of food waste reduction initiatives. The results are presented in Figure 4. We observe that the number of interventions already being implemented are highest among the Activists, the top being Noise Reduction (53%), Flexible Portions (45%), Improved Communication (43%) and Caregivers' Training (43%). Overall, the average rate of intervention implementation in this cluster is 30%.

The Environmentalists cluster rates next in execution of initiatives (23%), the top being Noise Reduction (43%), Flexible Portions (41%), enhance Compost & Donations (34%) and Caregivers' Training (31%). The Socials cluster seems to focus on initiatives that most engage people, the top being Advanced Training for Caregivers (39%), Noise Reduction (37%), Improved Communication and Break Before Lunch (32%). The average rate of implementation of interventions in the Socials cluster is 21%. Laggards rate low in most initiatives, where the average rate of intervention is only 16% in this cluster.

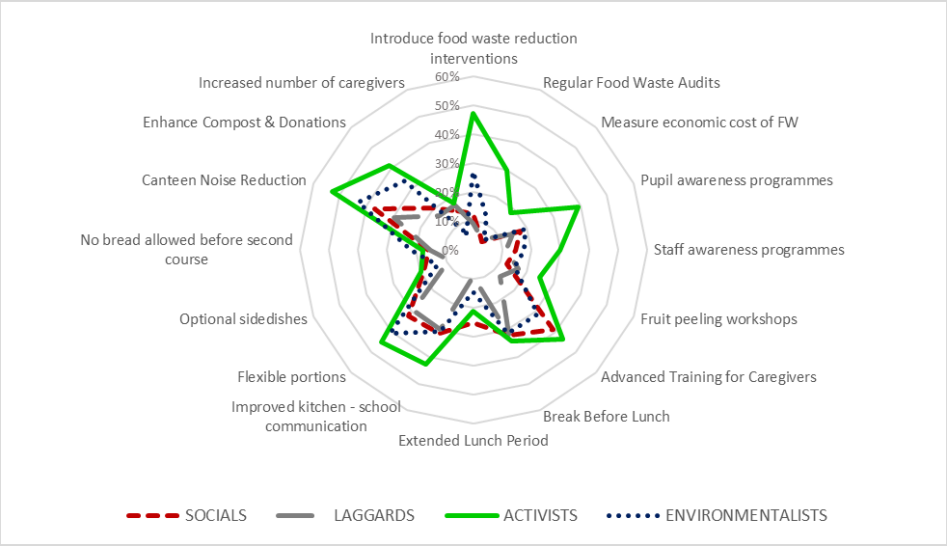

Figure 4: Rate of Currently Implemented Interventions (%)

Although we found relevant differences among the clusters with regard to the actual rate in which initiatives are already being implemented (Figure 4), we found no big differences with regard to the most preferred initiatives among those not yet implementing them.

6. Discussion

Contrary to what may seem common-sense from the public nature and social view of many educational institutions, school leaders declare to be more engaged in environmental initiatives and goals than in social issues. This said, there seem to be 2 different ways that schools can follow in their path towards sustainability: schools either emphasise social initiatives or the environmental ones before becoming a fully sustainable school, as shown in Figure 5. Considering a fully sustainable school as the one that makes efforts and progress on all three dimensions of sustainability, as stated by Henderson (2004), it seems that the most frequent paths are either strongly emphasizing social issues first or focusing on environmental issues first. There is no holistic vision of a sustainable school during the first stages in the evolution.

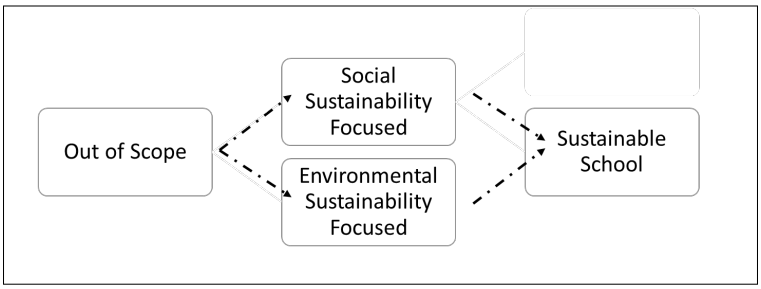

Figure 5: Evolution Towards a Sustainable School

With regard to food waste, little is done to fight against it, even by schools in the Activists or Environmentalists clusters probably due to its low visibility (Derqui et al., 2016) as well as to headteachers not being close to where waste is produced (US General Accounting Office, 1996). In order to improve the sustainability of educational institutions, a big effort needs to be made to increase: school management's visibility and awareness of the amount of food that is wasted in school canteens. Initiatives aiming to increase awareness on food waste are rarely implemented, while the acceptability of such initiatives, when presented to school headteachers is high in all clusters. Public policy makers and catering firms aiming to increase the sustainability of the system should prioritise these type of interventions when addressing school top management.

Our study is based on a quantitative survey which permits a large collection of information and provides a holistic view. Nevertheless, a qualitative study could enrich our findings and help to improve our analysis on the different profiles of schools. Moreover, a longitudinal research project could aid in the understanding of the process of transformation followed by sustainable schools. Moreover, an additional limitation of this study may be that it is based on the school leaders` opinion (through self-administered responses to our questionnaire), and thus a bias between what they say and what is really done can happen, as highlighted by Jackson (1986).

7. Conclusion

The research shows outstanding results. First, the study stresses that little is currently done at schools to minimise food waste. This is due to low awareness on the issue: headteachers mistakenly perceive their canteens to be efficient in adjusting the amount cooked and that their pupils consume all the food served. Second, it shows that

schools can be split into 4 clusters where the largest one (the Activists) outperforms in all sustainability issues while the smallest group is out of scope. We may conclude that Spanish schools are largely engaged in sustainability issues although this does not often include canteen food waste reduction. This result echoes previous research: school headteachers do not consider food waste to be a relevant issue in their canteens, despite the results of numerous quantifications done by scholars at school canteens. School leaders are not concerned about FW because they are not aware of it being a relevant issue, while scholars agree on the fact that a lot of food is wasted. We suggest that increasing school management's visibility and awareness on the issue of food waste would result in a step forward for schools on their path towards sustainability.

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Appendix 1: Survey Questionnaire

SECTION 1: Institutional Information		
I1	Name of the person answering the survey: (Not obligatory)	
I2	Position (Role)	
I3	Number of students (Primary graders/Secondary graders)	
I4	Do you have any environmental certification?	Yes/No/In process
I5	If Yes, which one?	
I6	Is there a canteen at the school?	Yes /No
SECTION 2: Canteen Management & Facilities		
CM1	Is the management of the canteen outsourced?	Yes, outsourced to a catering company/Yes, but not to a catering firm/No, it is managed by the school
CM2	How is food supplied in the school?	The school has an on-site kitchen/The food is brought prepared but cold and is heated at the school/The food is brought prepared, hot and ready to serve
CM3	Is there a person with the specific position of head of the canteen or similar?	Yes, there is a person solely devoted to management of the canteen/Yes, there is a canteen manager who also has other duties/No

CM4	Who are the people who supervise the pupils in the canteen?	Teachers/Supervisors just for the canteen/Others (please indicate
CM5	The average number of primary school pupils who eat each day in the school is	
CM6	The average number of supervisors monitoring the primary school meals is	
CM7	The average number of secondary school pupils who eat each day in the school is	
CM8	The average number of supervisors monitoring the secondary school meals is	
CM9	The school has a self-service line	Yes/No
CM10	The pupils go to the self-service lines to serve themselves.	Yes/no/depends on the age
CM11	Food is served to the pupils at the tables	Yes/No
CM12	Plates are used instead of preformed trays	Yes/No
CM13	Pupils can choose between more than one option for each dish	Yes/No
CM14	Pupils can choose if they want a side dish	Yes/No
CM15	Pupils have the option of taking bread	Yes/No
CM16	Are measurements of food waste carried out in the school?	Yes, on a regular basis by the catering company/Yes, on a regular basis on the school´s own initiative/No, never
SECTION 3: School Sustainability		
CS1	Our school has a clear and consistent sustainability strategy	1-5
CS2	Our school is ahead of other schools on sustainability issues	1-5
ES1	Our school devotes efforts and resources to minimising the school´s environmental footprint	1-5
ES2	The school devotes efforts and resources to reducing energy consumption	1-5
ES3	The school devotes efforts and resources to reducing the consumption of paper	1-5
ES4	The school devotes efforts and resources to reducing the consumption of water	1-5
ES5	The school devotes efforts and resources to reducing food waste	1-5
SS1	The school devotes efforts and resources to promoting volunteering among pupils	1-5
SS2	The school devotes efforts and resources to collaboration with NGOs	1-5
SS3	The school devotes efforts and resources to social causes in the school´s area	1-5
SS4	The school devotes efforts and resources to satisfying the needs of the most vulnerable or those at risk of exclusion	1-5
SECTION 4: Food Waste		
FW1	The canteen is part of the school´s educational project	1-5
FW2	A large amount of food waste is produced in the canteen	1-5
FW3	Most of the pupils eat everything they are served	1-5
FW4	Normally more portions are prepared than are needed	1-5
FW5	Families are very involved in reducing food waste at school	1-5
FW6	The catering company is very involved in reducing food waste at school	1-5

FW7	School management is very involved in reducing food waste at school	1-5
FW8	The Regional Government of Catalonia is very involved in reducing food waste at schools	1-5
FW9	Parents are responsible for education about food	1-5
FW10	The school is responsible for the amount of food wasted in the canteen	1-5
FW11	The catering company is responsible for the amount of food wasted in the canteen	1-5
FW12	The Regional Government should apply measures and regulations in order to reduce food waste in schools	1-5
SECTION 5: Suggested Interventions		
S1	Apply measures in order to reduce food waste in my school	1-5/Currently applied
S2	Carry out regular measurements of the food thrown away in my school	1-5/Currently applied
S3	Reliably estimate the financial cost of food waste	1-5/Currently applied
S4	Promote awareness raising programmes for pupils in order to encourage them to leave less leftovers on their plate	1-5/Currently applied
S5	Promote awareness programmes for employees in order to reduce waste in the kitchen	1-5/Currently applied
S6	Change timetables so that there is a break time before lunch	1-5/Currently applied
S7	Extend the available time for eating	1-5/Currently applied
S8	Introduce fruit peeling workshops (teach the little ones to fully make the most of fruit)	1-5/Currently applied
S9	Improve school - canteen communication in order to more closely adjust the amount cooked to the planned number of diners	1-5/Currently applied
S11	Make portion sizes flexible	1-5/Currently applied
S12	Allow the side dish to be optional	1-5/Currently applied
S13	Not allow children to take bread until they have finished their starter	1-5/Currently applied
S14	Reduce noise in the canteen and create a more pleasant atmosphere	1-5/Currently applied
S15	Facilitate composting in the school and the donation of food	1-5/Currently applied
S16	Increase the number of canteen supervisors	1-5/Currently applied
S17	Make the canteen supervision professional	1-5/Currently applied